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EGGSHELL DAMAGE AND MASTER CONTAINER COSTS OF TWO SHELL EGG MARKETING SYSTEMS

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PREFACE AND ACKNOWLEDGMENTS

This report is part of a continuing research program of the Agricultural Research Service designed to find more efficient and less costly methods of packaging, handling, and transporting agricultural products from producer to consumer.

The egg grading on which parts of this report are based was performed by Federally licensed inspectors under the general supervision of Ray Greenfield, National Supervisor, Grading Branch, Poultry Division, Agricultural Marketing Service, U.S. Department of Agriculture under a reimbursable agreement for services between Federal agencies.

Grateful appreciation is extended to R. W. Sauder, Lititz, Pa., and Giant Foods, Inc., Landover, Md., for cooperating in this study.

Appreciation is also extended to Judson McQuire of the ARS Biometrics Laboratory for assistance in setting up a computerized program to analyze the data, to Clarence E. Harris, Market Specialist, Animal Products Marketing Laboratory, for providing the author with valuable technical information, and to O. F. "Scotty" Johndrew, Jr., and Joe Regenstein, Cornell University, for their helpful review of the manuscript.

This study was conducted under the general direction of John C. Bouma, Chief, Market Operations Research Laboratory.

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EGGSHELL DAMAGE AND MASTER CONTAINER COSTS OF TWO SHELL EGG MARKETING SYSTEMS

By Bruce E. Lederer [1]

SUMMARY

The rate of eggshell damage and master container costs when shell eggs are packaged in four types of master containers within each of and between two major delivery systems were determined. System 1 was direct-store delivery from packing plant to retail store. System 2 was warehouse-to-store delivery from packing plant to and through a central distribution warehouse and to retail store.

The four containers studied were: (1) corrugated collapsible paperboard cases, (2) corrugated noncollapsible paperboard (one-way) cases, (3) plastic baskets, and (4) wire baskets.

The study was conducted in one large egg packing plant, one central distribution warehouse, and two retail stores.

All damage found in this study was subjected to analysis of variance and Duncan's multiple range test to separate means. Statistical significance was at the 5-percent level of probability.

The total mean rate of eggshell damage in system 1 regardless of container type amounted to 1.0 percent checks and 0.20 percent leakers; in system 2, amounted to 1.26 percent checks and 0.14 percent leakers. These differences were not statistically significant.

The mean rate of damage by container type after leaving packing plant, regardless of system, was significant for leakers only between collapsible cases (0.0 percent) and plastic baskets (0.41 percent). This was attributable to the high rate of damage occurring within plastic baskets in system 2.

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The mean rate of damage by container type within system 1 was significant for checks between plastic baskets (0.60 percent) and one-way cases (1.50 percent).

The mean rate of damage by container type within system 2 was significant for checks within both wire baskets and one-way cases with 0.60 and 0.90 percent, respectively, when compared with plastic baskets with 2.37 percent.

The mean rate of damage by containers between systems 1 and 2 was significantly different for checks between plastic baskets in system 1 (0.60 percent) and plastic baskets in system 2 (2.37 percent).

Costs of master containers, regardless of system, ranged from a low of $58.50 per 750 case trailerload with the wire baskets to a high of $172.50 per 750 case trailerload with the corrugated paperboard, noncollapsible (one-way) case. This reflects a potential savings of up to $114.00 per trailerload.

This study did not attach dollar figures to the damage. Damage cost is a variable factor based on several considerations, one of which is the legal and consumer acceptance of different damage levels. If the difference in rates of eggshell damage in this report do not appear substantially important, the author recommends using container costs as a major guideline in selection. These costs do not preclude the consideration of other factors, such as the convenience of the one-way case or the lower labor cost for pricing and displaying baskets at the retail store. These factors were not within the scope of this study.

BACKGROUND

A study[2] by the U.S. Department of Agriculture identified and determined the costs of two systems of handling, packaging, and transporting shell eggs from the end of the packing line to the display counter in retail stores. System 1 was direct-store delivery from packing plant to retail store; system 2 was warehouse-to-store delivery from packing plant to and through a central distribution warehouse, and to retail store. Various combinations of handling equipment and master cases were examined within each of these two systems.

The most noteworthy findings of that study indicated the potential savings that could be realized by incorporating the least costly master case. However, no attempt was made to measure the rate of eggshell damage occurring in these cases.

2/ Lederer, Bruce E. An Evaluation of Two Shell Egg Marketing Systems. U.S. Dept. Agr. Market. Res. Rpt. No. 1046, 1975.

PURPOSE OF STUDY

The purpose of this study was to determine the rate of eggshell damage and container costs when shell eggs are packaged in four types of master containers within each of and between delivery system 1 (direct-store) and system 2 (warehouse-to-store). Therefore, this report is presented in two parts: (1) Eggshell damage and (2) container cost.

The damage section analyzes the rate of shell damage occurring at the inspection locations along each of the two marketing channels by type of master container used.

The cost section evaluates the costs of using the four master containers.

MATERIALS AND METHODS

Information was obtained from owners and managers of packing plants, central distribution warehouses, retail stores, and box and equipment companies. Additional information was obtained from Federal and State government officials, university personnel, and others involved with the handling of shell eggs.

The shell eggs were large grade A. They came from the same flock of Shaver birds that had been laying for approximately 7 months. These eggs were kept at temperatures ranging from 55° to 70° F with an 80 percent relative humidity, and were one day old when they arrived at the packing plant.

Eggshell Inspection

During the first week shell eggs were inspected at a large packing plant in Pennsylvania, a central distribution warehouse in Maryland, and two retail stores (system 2 -- warehouse-to-store). Clearances were obtained to allow Federal Egg Graders access to retail stores.

At the packing plant a grader initialed and numbered all samples consecutively as the samples reached the end of the packing line. Cross reference was made to the actual sample number by graders at each location along the marketing channel when recording grading results.

At each checkpoint graders inspected the eggs in the marked samples according to the standard U.S. Department of Agriculture random sampling procedures 3/.

Examination was for checks and leakers only. A check is an individual egg that has a broken shell or crack in the shell but with the shell membranes intact. Checks may range from a very fine hairlike check (blind check) that is discernible only before the candling light or by "belling" to plainly visible

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3/ See appendix for sampling procedures.

dented checks. Such eggs will not keep well or stand even moderate rough handling.

A leaker is an individual egg that has a crack or break in the shell and shell membranes to the extent that the egg contents are exuding or are free to exude through the shell. An egg that has a portion of the shell missing (in excess of an area 1/4-inch square) is considered a leaker even though the shell membrane is intact. Leakers or smashed eggs are considered as loss in the USDA regulations.

At the packing plant checks were marked on the large end with a red lead pencil. After leakers were recorded, they were removed and replaced with sound shell eggs.

At the warehouse, graders inspected the previously checked eggs (marked in red) only to determine if the checks had developed into leakers. Those leakers were then recorded and replaced with sound shell eggs. Any additional checks found were marked with a green lead pencil and recorded. Checks that had a red lead mark were not recorded.

After sampling, the cartons were returned to the same layer from which they were taken.

At the two retail stores, eggs with either a red or green mark were inspected to determine if they had developed into leakers. The remainder of the eggs in the sample were inspected for damage that might have occurred between the warehouse and the retail store. Checks having either a red or green mark on them were not recorded on the worksheet. After the location of new damage was determined and recorded, all damaged eggs were removed from the cartons and discarded. The remainder of the eggs were consolidated into complete dozens and sold at the store.

During the second week, eggs were graded at the packing plant, shipped directly to the same two retail stores, and graded in the same way as in the first week.

After information on egg shell damage was collected, data were statistically analyzed by analyses of variance and Duncan's multiple range test to separate means.

Master Containers

The four types of master containers studied (fig. 1) were as follows:

(1) Corrugated collapsible paperboard case, (30-dozen capacity), 200-pound bursting strength, built-in short Z liner, good used condition, tops taped.

(2) Corrugated noncollapsible paperboard case, (30-dozen capacity), 200-pound bursting strength, short Z liner, new condition, tops taped. (This is also referred to as a one-way case.)

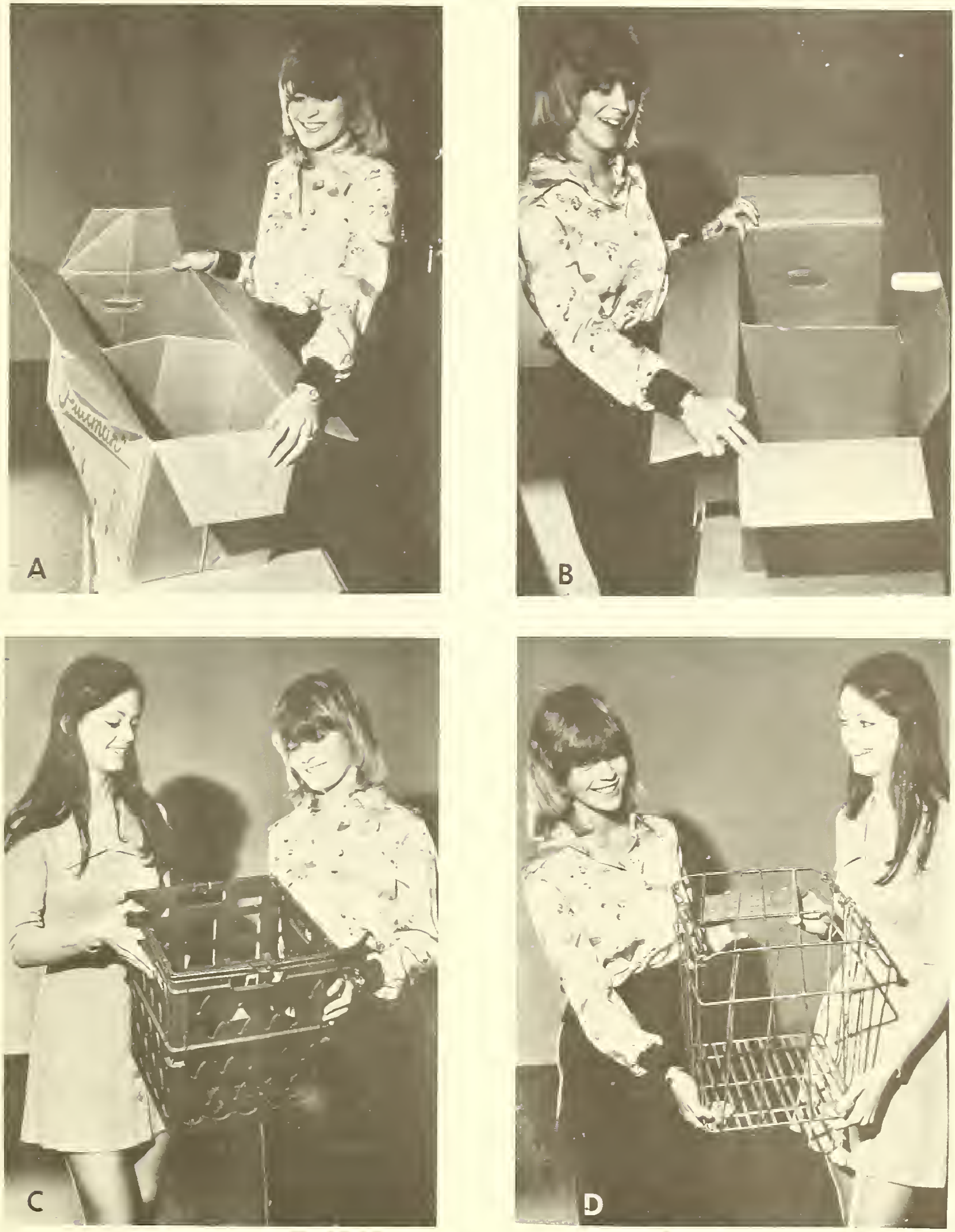

Figure 1.--Four master containers: A, corrugated collapsible paperboard case (30-dozen capacity); B, corrugated noncollapsible paperboard (one-way) case (30-dozen capacity); C, plastic basket (15-dozen capacity); D, wire basket (15-dozen capacity).

(3) Plastic basket (15-dozen capacity), good used condition.
(4) Wire basket (15-dozen capacity), good used condition.

When both baskets and cases are referred, the term "container" will be used.

All shell eggs were packaged in molded pulp pillar post cartons (fig. 2), which were normally used within the systems.

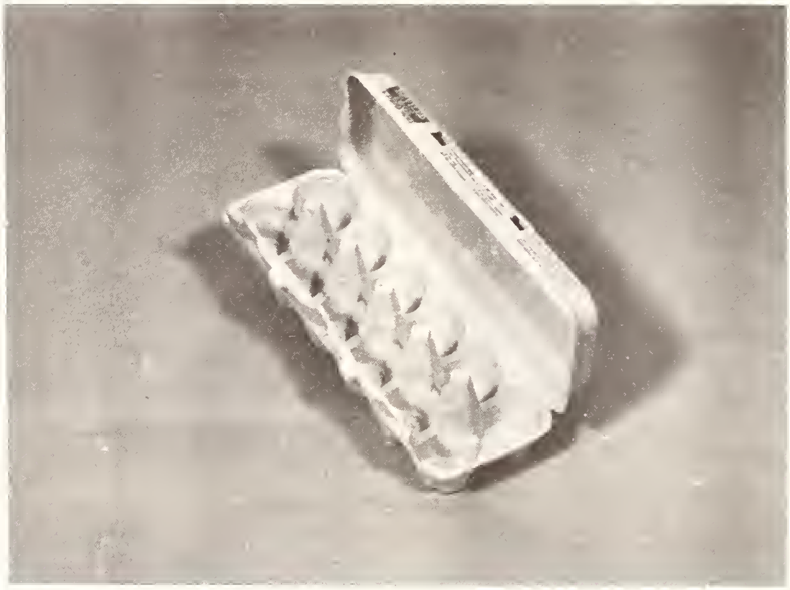

Figure 2.--Molded pulp pillar post carton.

There were 10 containers of eggs sampled for each type of container for a total of 40 containers within each system. For the two systems, this amounted to a total sample of 80 master containers. The total number of eggs inspected (candled) for the systems amounted to the following:

Location	Systems	Number
Packing plant	1 and 2	8,000
Warehouse	2	4,000
Retail store	1 and 2	7,700 [4]
Total		19,700

Each of the two shipments from the packing plant was made on a 38-foot refrigerated tractor-trailer for a one-way driving distance of approximately 130 miles to the warehouse (system 2) and to the retail stores (system 1). The trailer was fully loaded and the egg containers were unpalletized. To equalize chances of damage, all test containers were placed at the rear of the trailer. Travel routes for each shipment were the same.

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[4] Of the shell eggs shipped from the packing plant, 300 were not inspected at one of the retail stores because the three plastic baskets in which they were contained tipped off of a pallet during receiving operations.

From the warehouse, the deliveries to each of the retail stores were made on 40-foot refrigerated tractor-trailers for a one-way distance of approximately 7 miles. Test containers were palletized and placed at the rear of the trailer. The trailers on which these eggs were delivered contained mixed loads of various food commodities.

EGGSHELL DAMAGE

This section describes how the shell eggs were handled from the end of the packing line to the final inspection at the retail stores, and the rate of eggshell damage occurring by type of master container within each of the two marketing systems and between each system. Descriptions and results are shown at each grading location (packing plant, central distribution warehouse, and retail stores).

Handling Procedures

Packing Plant

The packing plant handled a large weekly volume and made system 1 and system 2 deliveries. Because the activities at this plant were virtually identical for both delivery systems, the following discussions apply to both.

After shell eggs were packed in cases or baskets on the packing line, they were moved by a conveyor to the end of the line where they were numbered and initialed by a Federal Egg Grader (fig. 3). The containers were then lifted by hand and carried about 5 feet to nearby 25-inch by 38-inch pallets and set down. Each type of container was assigned to a separate pallet and stacked 10 to a pallet. A manual hydraulic pallet transporter then moved the pallets about 100 feet to the cooler. After approximately 18 hours in the cooler the pallets were moved about 120 feet to the grading station and the eggs were inspected.

After the inspection, containers were restacked 10 to a pallet and moved to cooler storage. After an additional 12 hours in the cooler, the pallet loads were moved by an electric pallet transporter a distance of 50 feet to the 38-foot refrigerated tractor-trailer. They were then handstacked in the rear of trailer (fig. 4) by type of container. This stacking arrangement assured the near equal treatment of sample eggs in transit.

Central Distribution Warehouse

Since System 1 (direct-store-delivery) bypasses the warehouse, this section discusses only system 2 (warehouse-to-store delivery). After arriving at the warehouse, the driver of the delivery truck unloaded the test

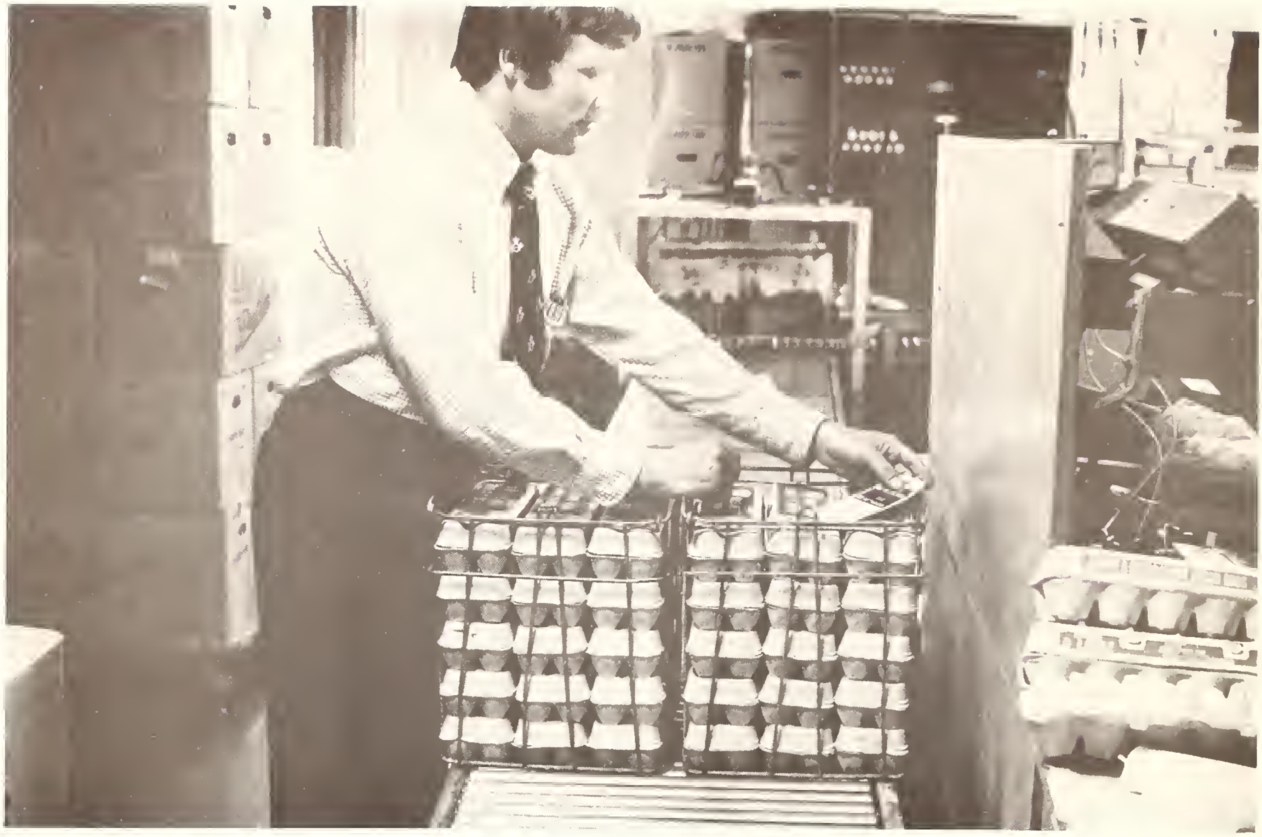

Figure 3.--Shell eggs moved by conveyor to end of line, numbered and initialed by a Federal Egg Grader.

containers by hand and stacked them on 48-inch X 40-inch pallets. All paperboard cases were stacked randomly on one pallet and all baskets on another pallet. Pallet loads were then transported about 200 feet to the rear of the warehouse where a special area had been set aside for inspection.

After inspection, the egg containers were divided equally and stacked randomly on two 48-inch X 40-inch pallets. Each of the pallets was then picked up by an electric pallet transporter which moved 300 feet to the loading area. Here, each pallet was placed at the rear of each of two trailers which were then delivered to each of the two retail stores.

Retail Store

Each of the two retail stores received two shipments of shell eggs. The first week they received eggs that had moved through the central warehouse (system 2), and the second week they received eggs direct from the packing plant (system 1). At the retail stores, transportation distance between the receiving area and storage area was approximately 35 feet.

Handling methods differed for the two types of deliveries because eggs

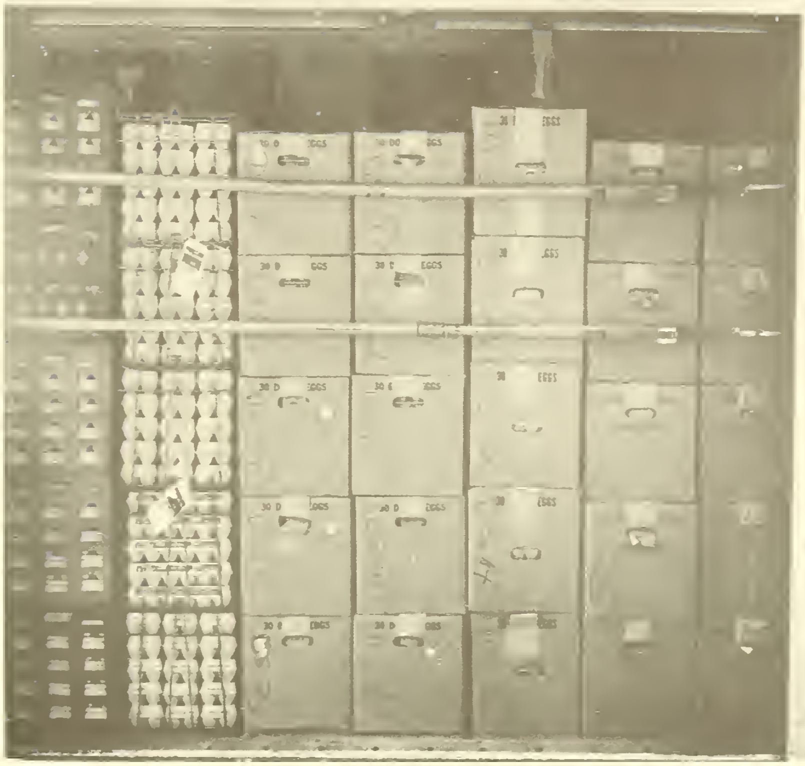

Figure 4.--Sample egg containers handstacked in rear of refrigerated tractor trailer.

arrived palletized from the warehouse and handstacked from the packing plant. In system 2 pallet loads were removed from the trailer by store personnel with electric pallet jacks. In system 1 unpalletized loads were unloaded from the trailer by the truck driver with a 4-wheel handtruck.

Inspection Results

This section reflects the rate of damage found at the various inspection stations.

Because one of the objectives was to measure the rate of egg shell damage while shell eggs were moved through each of the two systems, emphasis was not placed on damage rates at the packing plant. The principle purpose for determining plant damage was to have a starting base upon which to add additional damage within the systems studied. Therefore, damage found at the packing plant has not been included in this discussion.

Table 1 shows the mean rate of damage in system 1 and 2 regardless of container type. The differences are not statistically significant at the 5-percent level of probability.

Table 1.--Total mean rate of eggshell damage in system 1 (direct-store) as compared with system 2 (warehouse-to-store) regardless of container type 1/

Type of damage and system	Inspection station		
	Warehouse	Retail store	Total
	Percent	Percent	Percent
Checks:			
System 1	--	1.00	1.00
System 2	0.75	.51	1.26
Leakers:			
System 1	--	.20	.20
System 2	.03	.11	.14

1/ Numbers connected by the same line do not differ significantly at the 5-percent level of probability.

Table 2 shows the mean rate of damage by container type regardless of system. There is a significant difference in the rate of leakers within the plastic baskets (0.41 percent) as compared with the collapsible cases (0.0 percent).

Table 2.--Mean rate of damage by type of container regardless of system [1]

Type of container	Checks
	Percent
Plastic basket	1.41
One-way case	1.20
Collapsible case	1.20
Wire basket	.80
	Leakers
	Percent
Plastic basket	.41
One-way case	.20
Wire basket	.10
Collapsible case	.00

[1] Numbers connected by the same line do not differ significantly at the 5-percent level of probability.

Table 3 shows the mean rate of damage by container type within system 1. There is a significant difference in the rate of checks between the shell eggs in the one-way cases (1.50 percent) and those in plastic baskets (0.60 percent).

Table 4 shows the mean rate of damage by container type within system 2. Although, at the warehouse there is no significant difference in damage, at the retail store there is a significant difference in the rate of checks in plastic baskets (1.57 percent) as compared with all other containers. It should be noted that 3 of the 10 plastic baskets of eggs delivered to the retail stores (5 baskets to each store) tipped off of the pallet during receiving operations at one of the stores. The rates in this table do not reflect damage to the eggs in the fallen baskets since they were eliminated from the sample when they fell.

Leakers in plastic baskets were higher than those in other containers at the retail store, though statistically insignificant.

The total mean rate of damage by container type within system 2 was significant for checks within both wire baskets and one-way cases with 0.60 and 0.90 percent, respectively, when compared with plastic baskets with 2.37

Table 3.--Mean rate of eggshell damage by type of container within system 1 (direct-store)

Type of container	Eggshell damage at retail store 1/
	Checks
	Percent
One-way case	1.50
Wire basket	1.00
Collapsible case	.90
Plastic basket	.60
	Leakers
	Percent
Plastic basket	0.30
One-way case	.30
Wire basket	.20
Collapsible case	.00

1/ Numbers connected by the same line do not differ significantly at the 5-percent level of probability.

percent.

Table 5 shows the mean rate of damage by container between the two systems. A significant difference is found between the checks within plastic baskets in system 1 (0.60 percent) and the checks within plastic baskets in system 2 (2.37 percent).

CONTAINER COSTS

Table 6 shows the estimated cost per trip per trailerload using four types of master containers and assuming that variables such as labor are constant.

The initial cost is based on information supplied by manufacturers, packing plant owners, and central distribution warehouse personnel. For the one-way case, the cost includes a short Z liner. The collapsible case contains its own built-in short Z liner.

Salvage value was estimated by salvage company and central distribution warehouse personnel.

The number of round trips per container was estimated by central warehouse and packing plant personnel.

Table 4.--Mean rate of eggshell damage by type of container within system 2 (warehouse-to-store)

Warehouse 1/		Retail store 1/		Total 1/	
Type of container	Checks	Type of container	Checks	Type of container	Checks
	Percent		Percent		Percent
Collapsible case	1.30	Plastic basket	1.57	Plastic basket	2.37
Plastic basket	.80	One-way case	.40	Collapsible case	1.50
One-way case	.50	Wire basket	.20	One-way case	.90
Wire basket	.40	Collapsible case	.20	Wire basket	.60
	Leakers		Leakers		Leakers
	Percent		Percent		Percent
One-way case	0.10	Plastic basket	0.57	Plastic basket	0.57
Wire basket	.00	Wire basket	.00	One-way case	.10
Plastic basket	.00	One-way case	.00	Wire basket	.00
Collapsible case	.00	Collapsible case	.00	Collapsible case	.00

1/ Numbers connected by the same line do not differ significantly at the 5-percent level of probability.

Table 5.--Mean rate of eggshell damage by four types of containers between systems 1/

Eggshell damage and system	Plastic basket	Wire basket	One-way case	Collapsible case
	Percent	Percent	Percent	Percent
Checks:				
System 1	0.60	1.00	1.50	0.90
System 2	2.37	.60	.90	1.50
Leakers:				
System 1	.30	.20	.30	.00
System 2	.57	.00	.10	.00

1/ Numbers connected by the same line do not differ significantly at the 5-percent level of probability.

Table 6.--Estimated cost per trip using four types of master containers

Type of container	Initial	Salvage	Trips per container	Return cost	Total cost Per container	Per 30-dozen	Per 750 case trailerload 2/
	Dollars		Number		Dollars		
Collapsible case	0.56	0.07	10	0.03	0.079	0.079	59.25
One-way case	.30	.07	1	-	.230	.230	172.50
Plastic basket	2.75	-	150 3/	.03	.048	.096	72.00
Wire basket	2.75	-	300	.03	.039	.078	58.50

1/ Effective as of August 1974.

2/ This would be equivalent to 1,500 baskets per trailer load.

3/ Plastic baskets tend to have a shorter life than wire baskets and are more prone to theft.

The return cost of the containers includes the extra handling required, but does not include backhaul trucking charges. In general, because the trucks return directly to the warehouse or packing plant after retail store deliveries, the return of empty cases does not add to the cost. If backhaul charges were considered, however, they would amount to approximately $0.01 per container.

The total cost per container per trip is equal to the initial cost less salvage value, divided by number of times container was used, plus return cost.

Costs range from lows of $58.50 and $59.25 per 750 case trailerload for the wire basket and the collapsible case, respectively, to a high of $172.50 for the one-way case. This reflects a potential savings of up to $114.00 per trailerload.

The large variation in costs between containers results from the number of reuses of baskets and collapsible cases compared with the one-way cases.

DISCUSSION

One should note that when shell eggs are normally received at the warehouse (system 2), they are moved to storage and then assembled for retail delivery. In assembly, a warehouseman generally handstacks containers of shell eggs on empty or partly loaded pallets, and moves those pallets from storage to the assembly area. Movement of the experimental shell eggs through this operation was not practical and, therefore, any damage that might normally occur was not measured. The assembly function was simulated, however, with the handling of the master containers during inspection.

This study determined the rate of eggshell damage and the container costs when shell eggs were packaged in four types of master containers within each of and between system 1 and system 2. The study did not attach dollar figures to the damage.

Damage cost is a variable factor based on several considerations, one of which is the legal and consumer acceptance of different damage levels. If the differences in rates of eggshell damage in this report do not appear substantially important, the author recommends using container costs as a major guideline in selection of containers. These costs, of course, do not preclude considering other factors, such as the convenience of the one-way case, or the lower labor cost for pricing and displaying baskets at the retail store. Such factors were not within the scope of this study.

Table 7 gives a summary of container costs and eggshell damage for each of the four containers and both systems.

Table 7.--Summary of container cost and eggshell damage rate per 750 case trailerload by systems and type of container

Type of container	Container cost	Eggshell damage in			
		System 1		System 2	
		Checks	Leakers	Checks	Leakers
	Dollars	Percent	Percent	Percent	Percent
Collapsible case	59.25	0.90	0.00	1.50	0.00
One-way case	172.50	1.50	.30	.90	.10
Plastic basket	72.00	0.60	.30	2.37	.57
Wire basket	58.50	1.00	.20	.60	.00

APPENDIX - SAMPLING PROCEDURES

One hundred shell eggs were candled from each sample case or basket. One-half of the total eggs candled from the corrugated cases were taken from the numbered and initialed end of the cases and the other one-half from the opposite end of the cases. For example, on odd numbered cases, such as 1, 3, and 5, the marked end of the case was examined and on the even numbered cases, such as 2, 4, and 6, the unmarked end was examined. Eggs within each case and basket were selected in the following rotation:

Case 1 - Cartons in layers 1, 2, and all except eight eggs in the third layer.

Case 2 - Cartons in layers 3, 4, and all except eight eggs in the fifth layer.

Case 3 - Cartons in layers 2, 3, and all except eight eggs in the fourth layer.

Case 4 - Cartons in layers 1, 2, and all except eight eggs in the fifth layer.

Case 5 - Cartons in layers 1, 4, and all except eight eggs in the fifth layer.

The above order of selection was repeated for all remaining sample cases and baskets.

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